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Development of Bio-PORec® system for polyhydroxyalkanoates (PHA) production and its storage in mixed cultures of palm oil mill effluent (POME)

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HIGHLIGHTS

- PHA accumulation could be achieved in mixed cultures.
- Feast–famine regime study gave the measure of actual accumulation phase for PHA.
- A successful lab scale, batch study fabrication system was demonstrated.

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ABSTRACT

High PHA production and storage using palm oil mill effluent (POME) was investigated using a laboratory batch Bio-PORec® system under aerobic-feeding conditions. Results showed that maximum PHA was obtained at a specific rate (q_p) of 0.343 C-mol/C-mol h when air was supplied at 20 ml/min. The PHA yield was found to be 0.80 C-mol/C-mol acetic acid (HAc) at microaerophilic condition and the mass balance calculation showed that PHA production increased up to 15.68 ± 2.15 C-mmol/cycle. The experiments showed that short feeding rate, limited requirements for electron acceptors (e.g. O_2, NO_3) and nutrients (N and P) showed lower tendency of glycogen accumulation and contributed more to PHA productivity.

1. Introduction

Polyhydroxyalkanoates (PHAs) accumulation in mixed culture has been widely reported by many researchers. PHA consists of various carbon contents and organic wastes (Salehizadeh and Van Loosdrecht, 2004) and both show properties similar to conventional plastic. PHA is recognized as a major component raw material in fabricating biodegradable plastics. In addition, biodegradable plastic is demanded now-a-days to reduce the unfavorable decomposition processes. On the other hand, the decomposition of biodegradable plastic can be achieved in a short period of time either by natural degradation or landfill disposal. Typically, the PHAs are known as polyesters of various hydroxyalkanoates and predominantly synthesized by numerous microorganisms as energy reserve materials. It could be synthesized under unbalanced growth conditions, i.e. by limitation of some essential nutrient and excess carbon source (Serafim et al., 2004). Many reports are available in the literature on microbial PHA production (Zafar et al., 2012). Moreover, PHA production using mixed culture from organic acid has been carried out (Salmiati et al., 2007). It has the potential to enhance the PHAs contents at low cost operations, i.e. simple equipment, friendliness environment, and cost effective substrates including industrial, municipal and agricultural wastes at massive scale (Rodríguez et al., 2011). Selection of a suitable carbon substrate is an important factor for optimizing the PHA production, as it could affect the PHA content, composition and the polymer properties. Over 40% of total operating expense for PHA production is related to the raw materials (Lee et al., 1999). Thus, the use of a low-cost carbon source is required in order to reduce the high production cost of PHA. The approach of mixed culture conditions could enhance the fast substrate utilization and thus more

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